mal bony architecture at the articular surfaces of both the tibial plateau and femoral condyles in the aging rhesus macaques. These images also confirmed marked extraarticular ossification and osteophytosis.
The corresponding micro-MRI images confirmed the association of cartilage loss in the weight bearing regions of the joint and defined areas of soft tissue alteration and degeneration in and around the joint space. These images were most valuable in the quantitation of cartilage loss as it relates to the bone remodeling process in progressive OA.
Conclusions: These results indicate that 4.7T micro-MRI and micro-CT can be used in the early detection of microscopic changes in the bone and cartilage in early degenerative disease of cartilage and bone respectively, in rhesus macaques. These methods are also valuable in the long-term studies of OA disease progression.

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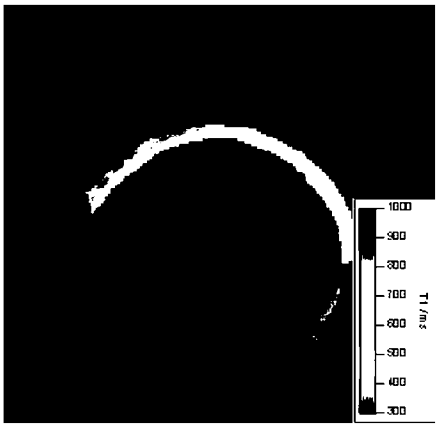
ASSESSING CARTILAGE HEALTH WITH 3-D DGEMRIC IN PATIENTS WITH FEMOROACETABULAR IMPINGEMENT

DC Wilson[1], B Maedler[2], CP Duncan[1], DS Garbuz[1], DR Wilson[1]
[1]Orthopaedics, UBC, Vancouver, BC, Canada; [2]Philips Medical Systems, Canada

Introduction: Femoroacetabular impingement (FAI), in which femoral deformities lead to damage of the labrum and/or cartilage, has been proposed as a mechanism explaining idiopathic osteoarthritis in non-dysplastic hips. This hypothesis is supported by histological analysis showing that femoral head cartilage from young patients with impingement exhibits degenerative changes similar to OA. Further tests of this hypothesis will rely on identifying a noninvasive method for assessing cartilage degeneration at the hip. Our objective was to assess the feasibility of using dGEMRIC (delayed gadolinium-enhanced magnetic resonance imaging of cartilage) to assess glycosaminoglycan (GAG) distribution in articular cartilage of patients with hip impingement.
Methods: Three-dimensional dGEMRIC was performed on four patients diagnosed with femoroacetabular impingement syndrome (hip pain, positive impingement test) and four controls matched for age and body mass index. All subjects were intravenously injected with 0.2 mM/kg Magnevist and asked to perform hip rotations for 10 minutes followed by 20 minutes of walking to facilitate diffusion of the contrast agent into the cartilage. Imaging started 75 minutes after injection. We used a Philips Intera 3T scanner with a flexible surface coil around the hip. T1 maps for 20 slices were generated from true sagittal images using a 3D IR-TFE sequence with the following parameters: TR/TE = 4.7/1.6, TI = 1.6, 1.2, 0.8, 0.4, 0.2, 0.15, 0.1 s, FOV = 220 mm, Matrix: 256 × 256 (interpolated to 512 x 512), 3mm slice thickness. Scan time was approximately 35 minutes.
Results: In two of the four subjects, the symptomatic subjects had dGEMRIC indices that were more than 150 ms lower than the matched controls and fell in the range of values for subjects with osteoarthritis in a previous study (Table 1). In the other two subjects the differences in dGEMRIC index were small. In all but one of the eight subjects the dGEMRIC index was lower in the anterior region than in the posterior region.

Table 1. Average T1 over four slices for four patients and their matched controls. ROI's were divided into anterior and posterior

	Average T1 for Four Slices					
	Patient T1 (ms)			Control T1 (ms)		
No.	Sex/Age	Anterior	Posterior	Sex/Age	Anterior	Posterior
1	F-19	630	569	F-24	779	792
2	M-36	453	577	M-34	726	793
3	M-40	624	636	M-35	614	725
4	M-36	692	711	M-34	691	751



Discussion: Our experience with the protocol and these results suggest that dGEMRIC can be used to assess cartilage changes in studies of femoroacetabular impingement. These results suggest that there are detectable changes in cartilage in some patients with femoroacetabular impingement, but no detectable changes in others. They also suggest that cartilage degeneration may be localized in FAI, which supports dividing the hip into regions of interest for analysis.

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VALIDATION OF A MAGNETIC RESONANCE IMAGING PROTOCOL TO ESTIMATE ARTICULAR CARTILAGE VOLUME IN THE ELBOWS OF MEDIUM-SIZED DOGS

AS Maclaughlan[1], R Savage[2], P Clegg[1], U Hetzel[1], D Hughes[3], JF Innes[1]
[1]Veterinary Clinical Science, University of Liverpool, Liverpool, United Kingdom; [2]Human Anatomy & Cell Biology, University of Liverpool, Liverpool, United Kingdom; [3]Burgess Diagnostics Ltd., Pickering, United Kingdom

Introduction: Canine elbow osteoarthritis (eOA) is a common, naturally-occurring, rapidly progressing disease. Non-invasive anatomical outcome measures in the live dog are currently non-existent. The aim of this study was to validate a magnetic resonance imaging (MRI) protocol for the assessment of articular cartilage volume (ACV), with a view to using this information to determine rate of disease progression in cases of eOA. This naturally-occurring model potentially provides a means to evaluate candidate structure-modifying agents.
Materials & Methods: Six radiographically normal elbows from three medium-sized, mixed-breed canine cadavers (two male & one female, age 1-2 years) were selected from dogs euthansed for reasons other than orthopaedic disease. All six limbs were scanned in a 1.0T MR scanner (Gyroscan, Philips) using the 3D-FFE-FS sequence - a 3D, fat-suppressed, gradient echo sequence as has been validated previously for ACV measurements in the human knee. Following scanning the joints were assigned randomly to have either cartilage dissection (group 1) or sagittal sectioning (group 2).
Group 1 elbows had their bony components (humerus, radius & ulna) dissected free from associated soft-tissues. The relevant bone ends (capitulum, radial head & ulnar notch/coronoid processes) were then laser-scanned using a high resolution laser scanner (DT1200, Laser Design Inc. MN). The cartilage was then removed from the bone ends, and the scanning process repeated. Using proprietary software a differential volume figure was calculated.
Group 2 elbows were frozen and sectioned longitudinally into

3mm slices using a diamond saw (E300, Exakt Apparatebau GmbH). Cartilage thickness measurements were made directly from the sections in order to provide comparison with the MRI thickness measurements.
The MRI data was exported in DICOM format to a post-processing package (AMIRA, Mercury Computer Systems, CA). The articular cartilage was manually segmented (outlined) for each slice in the data set. The software then reconstructed a measurable, three-dimensional volume from this data.
Results: 'On-screen' cartilage thickness measurements in the midline, sagittal slice were 0.5-1.0mm. These figures correlated well with the histomorphometry data. The cartilage volumes attained via post-processing again, also correlated well with the 'manual' measurements obtained by dissection and laser scanning.
Discussion: Our studies suggest that good articular cartilage signal can be obtained using a currently available, clinical MRI sequence. We are also able to use the MRI data to estimate the ACV in the normal canine elbow. Further studies will be aimed at investigating the ability of MR to detect changes in ACV in eOA-affected dogs via serial measurements; these data are currently being obtained as part of an ongoing, longitudinal study.
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ISOMETRIC MUSCLE STRENGTH AND JOINT SPACE WIDTH IN DOMINANT AND NON-DOMINANT KNEE OSTEOARTHRITIS

CS Mara, AMV Coimbra, AM Samara, EMB Pachecco, IB Coimbra
Rheumatology, State University of Campinas (UNICAMP), Campinas, SP, Brazil; Radiology, State University of Campinas (UNICAMP), Campinas, SP, Brazil

Objective: To measure isometric muscle force and compare it with the joint space width (JSW) in dominant and non-dominant knees in radiographs of the medial and lateral tibiofemoral compartments (semi-flexion with weight bearing) of osteoarthritic and healthy patients.
Methods: This study consisted of 48 patients with bilateral knee osteoarthritis (OA), classified as grades II and III according to the Kellgren- Lawrence (K&L) grading scale and 13 asymptomatic clinically and radiologically women. The JSW was measured in weight bearing semi-flexion radiographs. Three examiners evaluated the joint space width using digital caliper. The joint space was measured at two sites along the joint margin of the medial and lateral compartments of the knee, at the mid-point and 10 mm from the extremity of each plateau. Isometric muscle force of the knee extensors using the Power Track II equipment.
Results: Increase in age is associated with reduced isometric muscle force and joint space width in both groups ($P<0,0056$) and lesser JSW ($P<0,0058$). When adjusted with the age variable, the isometric muscle force in both OA and healthy individuals was not different and the strength muscle did not increased when the joint space width was greater. The JSW was greater in dominants knee ($P<0,032$) as compared with non dominant knee.
Conclusion: When adjusted to the age variable, isometric muscle force in OA patients (K&L grading II and III) and in healthy individuals did not differ, probably as a result of selective muscle fiber loss used in this type of contraction. Hence, isotonic as well as isometric exercises should be projected so that both types of muscle fibers benefit. Aging is a very important factor in this disease, not only due to the reduction and compromise of joint cartilage but due to reduced structural functions that result in an overall comprise of the joints.

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NOVEL ASSESSMENTS OF SUBCHONDRAL BONE AND ARTICULAR CARTILAGE SURFACE IN THE RAT MENISCECTOMY MODEL OF OSTEOARTHRITIS

H Yasui[1], J Hata[1], K Yamana[1], H Takagi[1], T Jinbo[1], Y Shimomoto[1], D Miura[1], Y Harada[1], Y Oue[1], Y Azuma[1], T Hayami[2], T Kamimura[1]
[1]Bio-medical Evaluation Research Department, Teijin Pharma Limited, Tokyo, Japan; [2]Department of Regenerative and Transplant Medicine, Niigata University Graduate School of Medical and Dental Sciences, Niigata, Japan

Aim of Study: To develop the evaluation methods to monitor the changes of subchondral bone and articular cartilage surface in the rat meniscectomy model of osteoarthritis (OA).
Methods: The medial collateral ligament of right knee of rat was transected and a single full thickness cut was made through meniscus (MNX). MNX rats were sacrificed at 3 or 4 weeks after the surgery (n=6 animals/group), and Sham-operated (SHM) rats at 4weeks. The tibiae were evaluated for three-dimensional (3D) structural change of subchondral bone using micro-focused X-ray computed tomography (micro-CT), followed by histological assessment. In order to evaluate the surface structure of the distal femoral chondyles, intact and dehydrated tissues were analyzed by High Accuracy Surface Scanning Laser system (HSL) and scanning electron microscope(SEM), respectively.
Results: In the tibial articular cartilage of MNX rats, progressive degeneration was observed by the histological scoring system. Osteophyte formation was observed at medial side of tibial subchondral bone by the micro-CT analysis, and the formed-osteophyte became larger in a time-dependent manner. But in SHM rats, the histological score was not different from that of intact rats, and osteophyte was not formed.
Using the intact samples by the HSL analysis, the surface of femoral chondyles was scanned as an intact condition, and the index of the irregulality was calculated. With the dehydrated samples by the SEM analysis, the fibrillation of the cartilage was observed. It was found that the degree of fibrillation was correlated with the calculated index.

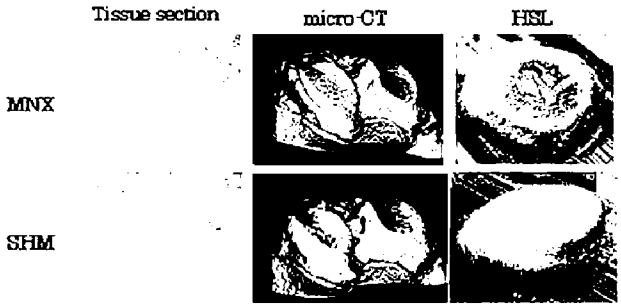

Fig. 1. Tissue sections, micro-CT and HSL images of right knee at 4 wks after operation. Tissue section, micro-CT image – tibia; HSL image – femoral chondyle.

Conclusions: Unlike the modified Mankin scoring system, these two items, 3D osteophyte structure and surface irregularity index, can be used to evaluate the complete structural changes of subchondral bone and cartilage degeneration in the rat OA model. So, micro-CT analysis and HSL analysis can be powerful methods for evaluating the progression of OA.